Benefit-Cost Analysis Supplementary Documentation

BUILD Grant Program

Market Street Marine Terminal

Main Wharf Rehabilitation

July 19, 2018

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Benefit-Cost Analysis Supplementary Documentation

1. Executive Summary

The Pease Development Authority, Division of Ports and Harbors, is requesting BUILD grant funds for use toward the rehabilitation of the Main Wharf at the Market Street Marine Terminal in Portsmouth, New Hampshire. The project will improve the structural integrity of the existing wharf and facilitate current operations, bringing it to a state of good repair. It is also designed to increase operational opportunities and extend the useful working life of the berth at the terminal. The improved wharf will support heavier cargo and improve operational efficiency on both the water and land sides, as well as provide easy and direct access to the Main Wharf, greatly enhancing safety, functionality and operational efficiency. It will also take advantage of a functional replacement completed by FHWA during a proximate bridge reconstruction. Table ES-1 summarizes the Main Wharf rehabilitation and associated economic benefits. Without the necessary improvements, the Port must turn away potential shippers, placing additional strain on the regional transportation infrastructure.

Table ES-1: Summary of Infrastructure Improvements and Associated Benefits

Current Status or Baseline & Problems to be Addressed	Changes to Baseline / Alternative	Type of Impacts	Population Affected by Impact	Economic Benefit	Summary of Results (Millions of $2017)
Main Wharf in need of rehabilitation to accommodate existing freight at port	Rehabilitate Main Wharf	Reduce truck vehicle miles traveled	Vehicle drivers	Monetized value of accident reduction	$16.81
			Government	Monetized value of pavement maintenance savings	$6.21
Main Wharf in need of rehabilitation to accommodate freight growth at port		Reduce pollutant emissions	Local, state, region, and national population	Monetized value of emission reductions	$1.64
		Remaining value of infrastructure after 20 years of wharf use	Port of NH, Pease Development Authority, and State of NH	Monetized residual value of improved Wharf	$5.00
		Decrease shipper costs	Shippers who utilize the port	Savings due to direct port shipments	$207.97

The period of analysis used in the estimation of benefits and costs corresponds to 33 months of construction and 20 years of operation plus a residual value after the final year. Operations at the port will not be disrupted during the construction period; as a result, no disruption costs are included in the analysis. The total project costs for this BUILD grant application are $12.5 million dollars

Table ES-2: Summary of Project Costs, in Millions of Dollars of 2017

Cost Category	Undiscounted Project Cost	Percentage of Undiscounted Project Cost
Capital Costs	$ 14.07	39%
Operation & Maintenance Costs	$ 22.05	61%
TOTAL COST	$ 36.12	

A summary of the relevant data and calculations used to derive the benefits and costs of the project are shown in the Benefit-Cost Analysis (BCA) model (in dollars of 2017). Based on the analysis presented in the rest of this document, the project is expected to generate $96.72 million in discounted benefits and $20.85 in discounted costs, using a 7 percent real discount rate. Therefore, the project is expected to generate a Net Present Value of $75.87 million and a Benefit/Cost Ratio of 7.41

In addition to the monetized benefits, the project would generate benefits that are difficult to quantify. A brief description of those benefits is provided below.

Safety

- The Market Street Marine Terminal coordinates with all agencies involved with security of the port, including the U.S. Coast Guard, NH Marine Patrol, the U.S. Customs, the FBI, the U.S. Navy, NCIS and the Department of Transportation. Specifically, the Terminal provides these entities access to its state-of-the-art camera system, which allows them the ability to reconnoiter or otherwise observe land based facilities, ships in port, and vessels transiting the area between the I-95 and Memorial Bridge. If the port were to close, there would not be sufficient revenue generated to support the staff required to operate this equipment.
- The port hosts advanced shipboard firefighting training. If there is an on-board fire, the vessel will be taken to the Market Street Marine Terminal as all other port facilities in the harbor are located near flammable fuels and other materials. The terminal is also used for oil spill training drills and, in the unlikely event of a spill, for staging response equipment.
- Security at the Portsmouth Naval Shipyard is elevated at all times. When there is a nuclear submarine docked, the Terminal is utilized to load and unload cargo from foreign flag vessels. This practice maintains some separation of the foreign vessels from the Naval Shipyard for security reasons. In the absence of the Main Wharf, it is not clear how the Shipyard would maintain this distance and security precaution.

Economic Competitiveness

- The port provides ship handling for numerous companies.
- Both port and rail services are available at the Market Street Terminal, and the combination is critical to the cost competitiveness of multiple regional businesses. An improved wharf will position the port to increase the exports and imports of current customers, be more productive, and expand existing operations.
- The port supports upstream businesses by providing special cargo handling services and a staging area for construction and maintenance of other facilities located along the Piscataqua River.
- The port provides a facility that meets the needs of identified new shippers, facilitating an increase in exports.

Quality of Life

- Rehabilitation of the Main Wharf improves the efficiency of the port and the harbor. This is beneficial to recreational boat users on the Piscataqua River. It also benefits other commercial vessels that are traveling up the Piscataqua to the private facilities north of the Market Street Terminal.

State of Good Repair

- The Main Wharf project includes the rehabilitation of a section of the wharf, bringing the facility to a state of good repair. In addition, the wharf project is designed with concrete containing recycled fly ash, and the deck is supported with steel caissons that provide large spans that limit impact to the Piscataqua riverbed.

Environmental Protection

- The rehabilitation design technique being proposed for the rehabilitation involves sustainable practices including maximizing the use of alternative and recycled materials.

Innovation, Partnership, and Non-Federal Revenue for Transportation Infrastructure Improvement

- These criteria are qualitatively addressed in the grant application.

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the grant application for the Market Street Marine Terminal Main Wharf Rehabilitation project.

Section 3, Methodological Framework, introduces the conceptual framework used in the BCA). Section 4, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the Market Street Marine Terminal Main Wharf Rehabilitation is expected to generate. Section 5, General Assumptions, discusses the general assumptions used in the estimation of project costs and benefits, while estimates of travel demand and traffic growth can be found in Section 6, Demand Projections. Specific data elements and assumptions pertaining to the long-term outcome selection criteria are presented in Section 7, Benefits Measurement, Data and Assumptions, along with associated benefit estimates. Estimates of the project's Net Present Value (NPV), its Benefit/Cost ratio (BCR) and other project evaluation metrics are introduced in Section 0,

Summary of Findings and BCA Outcomes. Next, Section 0,

Table 4: Estimates of Economic Benefits, Millions of 2017 Dollars

Primary Selection Criteria	Benefit Categories	Undiscounted Benefits	7% Discount Rate	3% Discount Rate
Safety	Accidents Benefits (2017$)	$ 16.81	$ 6.91	$ 11.19
State of Good Repair	Residual Benefits (2017$)	$ 5.00	$ 0.98	$ 2.46
	Pavement Maintenance Benefits (2017$)	$ 6.21	$ 2.55	$ 4.13
Economic Competitiveness	Shipper Cost Savings Benefits (2017$)	$ 207.97	$ 85.46	$138.44
Environmental Protection	Emissions Reduction Benefits (2017$)	$ 1.64	$ 0.82	$ 1.19
Quality of Life	Qualitative only	n/a	n/a	n/a
Total Benefit Estimates		$ 237.64	$ 96.72	$157.42

This benefit cost analysis compares the monetized benefits listed above to the overall project cost. Total discounted costs are estimated to be $20.85, and $96.72 million is estimated for total benefit (discounted at 7%). Annual costs and benefits are computed over the lifecycle of the project (20 years). The project is estimated to yield a Benefit/Cost ratio of approximately 7.41. Considering all monetized benefits and costs, the estimated internal rate of return of the project is 44.03 percent.

Table 5: Estimates of Economic Benefits, Millions of 2017 Dollars

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	$96.72	$157.42
Total Discounted Costs	$20.85	$27.66
Net Present Value	$75.87	$129.76
Benefit / Cost Ratio	7.41	10.95
Internal Rate of Return (%)	44.03%	
Payback Period (years)	7	

As discussed previously, if the Port is repaired, there has been extensive interest from a container shipper to move a portion of his operations to the Market Street Marine Terminal. This movement is expected to bring an additional 12,000 containers by 2024 and up to 15,000 containers by 2028. Of these containers, approximately half would be diverted from other Ports, and 20 percent of these (approximately 1,200 in 2025) would come from Montreal. The other half of the containers would be new business that would result from the level of service provided by the Port and the ability of the shipper to expand his business due to increased efficiencies.

Following the same methodology as the base analysis, when these new containers are accounted for, the Net Present Value of the project at a 7 percent discount rate increases to $105.62 million, resulting in a BCR of 9.91 and an internal rate of return of approximately 48.56 percent.

BCA Sensitivity Analysis, provides the outcomes of the sensitivity analysis. Additional data tables are provided within the BCA model including annual estimates of benefits and costs to assist the U.S. Department of Transportation (USDOT) in its review of the application.[1]

3. Methodological Framework

The BCA conducted for this project includes the monetized benefits and costs measured using USDOT guidance, as well as the quantitative and qualitative merits of the project. A BCA provides estimates of the benefits that are expected to accrue from a project over a specified period and compares them to the anticipated costs of the project. Costs include both the resources required to develop the project and the costs of maintaining the new or improved

[1] While the models and software themselves do not accompany this appendix, they are provided separately as part of the application.

asset over time. Estimated benefits are based on the projected impacts of the project on both users and non-users of the facility, valued in monetary terms.[2]

While BCA is just one of many tools that can be used in making decisions about infrastructure investments, USDOT believes that it provides a useful benchmark from which to evaluate and compare potential transportation investments.[3]

[2] USDOT, Benefit-Cost Analysis Guidance for Discretionary Grant Programs, June 2018.

[3] Ibid.

The specific methodology developed for this application was developed using the BCA guidance developed by USDOT and is consistent with the BUILD program guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the build and no-build scenarios;
- Assessing benefits with respect to each of the eight merit criteria identified in the NOFO);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using USDOT guidance for the valuation of travel time savings, safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by USDOT (7 percent, and 3 percent for sensitivity analysis); and
- Conducting a sensitivity analysis to assess the impacts of changes in key estimating assumptions.

4. Project Overview

The Pease Development Authority, Division of Ports and Harbors, is requesting BUILD discretionary funds for use toward the rehabilitation of the Main Wharf. The project will improve the structural integrity of the existing wharf and facilitate current operations. It is also designed to increase operational opportunities and extend the useful working life of the berth at the terminal.

The project will consist of a 17,500 square foot deck rehabilitation that will replace the deteriorating wharf access bridges by decking the open water area between the existing shoreline sheeting and the back of the current Main Wharf. This will provide easy and direct access for the entire length of the Main Wharf, assuring continued use for ocean commerce and greatly enhancing its safety, functionality and operational efficiency.

4.1 Base Case and Alternatives

Two alternatives were compared in the benefit-cost analysis, a build and no-build scenario. The build scenario represents the Main Wharf rehabilitation as described in the Project Overview, with the continuation of service for bulk cargo and project cargo. The no-build scenario reflects no improvements in the Main Wharf and complete closure of the Market Street Marine Terminal in 2020.

There is interest on the part of several potential shippers to operate through the Market Street Marine Terminal. One shipper estimates that an improved main wharf would enable his business to move its operation to the Port of New Hampshire, resulting in 6,000 containers per year utilizing the port. These containers are currently being handled by the Ports of Baltimore, New York and Montreal. While this would represent a diversion from other ports, there would be multiple societal benefits, including emissions, congestion and pavement maintenance savings generated from this shift.

In addition, it is expected that the number of containers using the Main Wharf would grow once the container operation had been relocated. This is due, in part, to industry demand but also because the Port of New Hampshire offers some locational and other advantages to this prospective shipper, as compared to other ports. The timing and likely share of this growth associated with the Port of New Hampshire specifically, rather than overall industry demand, are uncertain. As a result, the container service is ***not*** included in the primary build analysis. A separate analysis was conducted on this scenario with results presented later in this document. Overall, the incorporation of the new container service results in a benefit-cost ratio of 9.9.

4.2 Types of Impacts

The proposed project would contribute to enhancing the economic competitiveness of the Nation through improvements in the mobility of people and goods within and across the study area. In this analysis, economic competitiveness is represented by a cost savings to shippers.

Between the project's maintenance of existing port activity and its ability to facilitate growth in waterborne cargo, the region's freight shippers and receivers will directly benefit through lower shipping costs. Shipper cost savings associated with the project, due to direct port shipments compared to longer-distance truck hauls, are estimated for this analysis.

By rehabilitating the Market Street Marine Terminal Main Wharf, the wharf will remain operational beyond 2021. The associated cargo laydown space will allow the port to meet future demand and capture users who have already shown an interest in the facility.

Pavement maintenance savings related to the roadway network is also a benefit generated by this project. Finally, the Main Wharf will maintain a residual value beyond the analysis period used in the BCA. This is another state of good repair benefit generated by the project.

If the port were to close, customers who currently use the facility would be forced to use alternative ports and truck some, if not all, of their cargo. With the wharf rehabilitation, some of these trucks would be removed from the highways, reducing the number of accidents associated with additional VMT.

Emissions reductions are generated by reduced VMT as well. Emissions are further reduced because transporting cargo by marine vessel results in lower emissions than transporting that same cargo by truck. When the wharf work is completed, reduced VMT will lead to emission savings. Emissions measured in the BCA include VOC (HC), CO, CO2, NOX, SO2, and PM, varying by auto and truck. In the results discussed below, CO and CO2 are not included in the benefits estimates. The model, which accompanies this application, includes a toggle for inclusion of these additional emissions benefits.

4.3 Project Cost and Schedule[4]

The Market Street Marine Wharf Rehabilitation project is comprised of eligible costs, per the NOFO, that include construction, reconstruction, rehabilitation, construction contingencies, environmental review, preliminary engineering, and design. A number of investments related to

[4] All cost estimates in this section are in millions of dollars of 2017, discounted to this year using a 7 percent real discount rate.

this project have been made in recent years totaling approximately $1.6 million in previously incurred costs.

It is estimated that the BUILD project will require $12.5 million in capital expenditures with construction commencing in December 2018 and completion anticipated in August 2021. Maintenance after the improvement is estimated to cost $500,000 every ten years. Operating costs are currently $1.1 million annually and anticipated to remain at this level after the wharf is improved. Previously incurred costs of $1.6 million are also relevant to this project.

The no-build scenario is predicated on complete closure of the Market Street Marine Terminal by the end of 2021 with no large maintenance expenditures before the closure.

4.4 Disruptions Due to Construction

No significant disruptions due to construction are anticipated.

4.5 Effects on Selection Criteria

The main benefit categories associated with the project are mapped into the eight merit criteria set forth by USDOT in the table below.

Table 1: Benefit Categories and Expected Effects on Selection Criteria

Primary Selection Criteria	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
Safety	Accidents Benefits	Reduction in VMT due to use of port rather than highways to transport goods reduces accidents on the roadway network.	Yes	Yes	Yes
State of Good Repair	Pavement Maintenance Benefits Residual Value Benefits	Port provides non-roadway option for transporting cargo, which reduces VMT and associated roadway maintenance expenses. Remaining value of port after period of analysis.	Yes	Yes	Yes
Economic Competitiveness	Shipper Cost Savings	Savings due to direct port shipments compared to longer-distance truck and rail	Yes	Yes	Yes
Environmental Protection	Emissions Reduction Benefits	Reduction in VMT due to use of port rather than highways to transport goods reduces overall pollutant emissions	Yes	Yes	Yes
Quality of Life			No	No	Yes

Primary Selection Criteria	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
Innovation			No	No	Yes
Partnership			No	No	Yes
Non-Federal Revenue for Transportation Infrastructure Improvement			No	No	Yes

5. General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of construction and including 20 years of operations.

The monetized benefits and costs are estimated in 2017 dollars with future dollars discounted in compliance with BUILD requirements using a 7 percent real rate, and sensitivity testing at 3 percent.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2017 dollars;
- The period of analysis begins in 2017 and ends in 2041. It includes project development and construction years (December 2018-August 2021) and 20 years of operations (2041);
- A constant 7 percent real discount rate is assumed throughout the period of analysis. A 3 percent real discount rate is used for sensitivity analysis;
- Opening year demand is an input to the BCA and is assumed to be fully realized in Year 1 (with no ramp-up); and
- Unless specified otherwise, the results shown in this document correspond to the effects of the Full Build alternative, rehabilitation of the Market Street Marine Terminal.

6. Demand Projections

From 2008 to 2012, tonnage handled at the terminal increased by approximately 10 percent. In 2012, the Terminal handled its highest volume of bulk and break bulk cargo in recent years reaching 381,800 tons of primarily salt, scrap metal, gypsum and special projects. Due to the deteriorating condition of the wharf, annual volumes have been declining ever since, reaching a historic low of 91,934 in 2015. Despite this decline in recent years, extensive interest in using the terminal remains should the repairs be completed? The port director is frequently asked

about facility use, but concerns related to the Main Wharf condition preclude the acceptance of this new business. The deterioration of the terminal is accelerating the loss of existing business, and the wear and tear on other infrastructure in the area. The destination of the shipments remains the same, even if these shippers can no longer use this particular port.

Current operations are sustained by various components of project cargo using the port. These include construction components related to the Sarah Mildred Long Bridge and the maintenance of some historic cargo and other special projects. The terminal no longer serves scrap metal, though the potential for its return does exist.

6.1 Methodology

As part of the benefit-cost analysis, forecasts of tonnage shipped to and from the port were developed. These forecasts were based on historical and existing activity at the port, and expectations of tonnage increases upon completion of the Main Wharf rehabilitation.

Salt

For the no-build scenario, it is assumed that salt tonnage reaches 180,000 tons in 2017 and is reduced by 25% each year following until the port closes in 2020. Salt is being shipped to the area for use on local roads, and if the port closes, the salt will be diverted elsewhere in the Portsmouth area. Thus, the salt is excluded from diversions in the no-build scenario. For the build scenario, it is assumed that salt tonnage will reach 290,000 tons following the opening of the rehabilitated Market Street Wharf and will increase by 3 percent per year until a capacity of 500,000 tons is reached.

Special Project Cargo

Numerous special projects are handled at the port. Most frequently, the cargo shipped and received is heavy machinery and equipment. The tonnage associated with these special projects has been increasing recently, and rehabilitation of the Main Wharf is expected to continue to support this growth. Once the Sarah Mildred Long Bridge reconstruction is complete, the port will also have additional lay down space that further positions the facility to accommodate new cargo.

For the no-build scenario, it is assumed that special project tonnage will remain consistent with the 2014 volumes until the port closes due to contractual agreements. In the build scenario, project cargo is anticipated to grow at 3 percent following the completion of the Main Wharf rehabilitation. At that point, the port will be equipped to handle more special projects, and all indications are that the demand for those shipping and receiving services will increase after the wharf is rehabilitated.

Bulk Cargo

For the build scenario, it is anticipated that the port will receive 10,000 tons of sand and gravel (other bulk cargo) per week (or 520,000 tons per year) when the Main Wharf rehabilitation is complete. No additional growth in this cargo is currently expected beyond this initial build assumption. The model that accompanies this application supports the evaluation of a scenario where this activity “ramps up” instead of being accommodated in the first year post construction.

It should be noted that in the no-build, half of this tonnage is anticipated to divert to the Port of New York and New Jersey. Facilities along the Piscataqua River are assumed to accommodate 60 percent of the remaining cargo with the final 40 percent diverting to other ports.

New Container Service

A shipper has approached the port regarding container transport at the Market Street Marine Terminal. Specifically, they have 12,000 containers that they would like to move through Portsmouth once the Main Wharf is rehabilitated. Approximately half of these containers are being shipped through other ports today and half would be completely new containers.

By moving this existing container traffic to the Port of New Hampshire from these other ports, vehicle miles traveled will be reduced resulting in decreased emissions costs, congestion, and other benefits. Shipper cost savings are also generated when these containers are shipped via sea rather than on trucks. The remaining 6,000 containers are estimated to be new business made possible because of the Market Street Marine Terminal's location. The following details how this potential new growth in containers was treated in the benefit-cost analysis of the Main Wharf rehabilitation.

The no-build scenario includes no container traffic, and the primary build scenario does ***not*** include container business at the port.

Because indications are that container service could be re-initiated with the wharf improvement, a second scenario (described above) for sensitivity analysis is considered. The following assumptions are made for the analysis that incorporates container growth at the port:

- 6,000 containers are currently being handled by the Ports of New York, Baltimore, and Montreal and would be moved to Portsmouth.
    - Forty percent of containers are handled by New York, 40 percent by Baltimore, and the remaining 20 percent are handled in Montreal.
    - Eighty-five percent of these containers arrive to the ports via truck from New England and are exported. The remaining 15 percent are shipped by rail and then exported.

In addition, it is expected that the number of containers shipped through Market Street Marine Terminal will continue to grow once the container operation has been relocated. This is due, in part, to industry demand but also because the Port of New Hampshire offers some locational and other advantages to this prospective shipper, as compared to other ports. It is expected that 6,000 new containers will be exported once the Main Wharf is improved. Once 12,000 containers are serviced at the port, it is assumed that container traffic would continue to grow for approximately five years to a maximum annual volume of 15,000. As mentioned previously, this container business is not incorporated in the primary build scenario. While the magnitude of the benefit is difficult to quantify, it is reasonable to assume (and corroborated by the prospective shipper) that a significant share of the potential growth in container exports is attributable to the Port of New Hampshire specifically, and not just overall industry demand. As a result, the second analysis incorporating containers was conducted for comparison purposes.

6.2 Assumptions

The following table presents the assumptions utilized in the base (no container service) and alternative (container service) benefit-cost analyses. Demand values can be found in the Supplementary Data.

Table 2: Assumptions Used in the Estimation of Demand

Variable Name	Unit	Value	Source
Annual growth for project cargo in no-build scenario until port closes	Percent	-12%	Recent port activity data provided by PDA
Annual growth for salt in no-build scenario until port closes	Percent	-50% (2018) -75% (2019	Port Director
Annual growth in sand & gravel (other cargo) after improvement	Percent	0%	Recent port activity data provided by PDA
Annual growth in project cargo and salt after improvement	Percent	3%	Recent port activity data provided by PDA
Growth in sand and gravel after improvement	Tons per week	10,000	Port Director
Tonnage reduction in 2021 when port closes	Percent	100%	Port Director
Truck trips per container	Number	0.9	HDR Assumption based on share of containers that will be on single vs. combination trucks

7. Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each benefit or impact category identified in Section 4 (Types of Impacts) and provides an overview of the associated methodology, assumptions, and estimates.

LIST OF BENEFITS ANALYZED

The benefits assessed for the Market Street Marine Wharf project are the following:

- Economic Competitiveness
  - Shipper Cost Savings
- State of Good Repair
  - Pavement Maintenance Savings
  - Residual Value
- Safety
  - Accident Reduction
- Environmental Protection
  - Emissions Reduction

- Quality of Life – qualitatively addressed in application narrative and earlier in this technical appendix
- Innovation – qualitatively addressed in application narrative
- Partnership – qualitatively addressed in application narrative
- New Non-Federal Revenue – qualitatively addressed in application narrative

7.1 Methodology

Economic Competitiveness – Shipper Cost Savings:

To quantify the anticipated economic outcomes of the rehabilitation of the Main Wharf, shipper cost savings were estimated.

Rehabilitation of the wharf means that the port will not close, and existing customers will be able to continue utilizing the facility for shipping and receiving. If the port closes, these customers would use other ports located farther away, which would result in increased costs to ship cargo due to the increased miles associated with its transport.

Based on discussions with the Port director, the likely alternative ports for current users are the Port of Boston, Massachusetts, the Port of New Haven, Connecticut, the Port of Providence, Rhode Island, and the Ports of Portland or Searsport, Maine. Since the final destination of the freight is not the Port where it enters, it is assumed that there is an average “last-mile” distance of 10 miles for all movements. This has been netted out of the increased distance for diversion as it will still need to be traveled to reach the final destination if the freight is diverted away from the Market Street Marine Terminal. The cost to ship freight from those other ports to their final destinations via truck was then estimated.

State of Good Repair – Pavement Maintenance Savings and Residual Value:

In the no-build scenario, the wharf is assumed to close by the end of 2021. Closure of the port will result in trucks taking longer, circuitous routes that will increase vehicle miles traveled and wear and tear on the pavement. To estimate pavement maintenance cost savings associated with the wharf rehabilitation, the pavement maintenance cost is applied to the increase in truck VMT that is attributed to the truck diversions.

For the purpose of this analysis, benefits were estimated for a period of 20 years after the completion of construction on the port. However, the useful life of the project is actually 50 years. In order to capture the un-used value of the investment, a residual value has been calculated.

Safety – Accident Reduction:

The reduction of accident costs, like other variable costs, is dependent on the reduction of vehicle miles. With the improved wharf, some vehicles will be removed from the roadways as shippers opt to use marine transportation instead of trucks to transport their freight. The reduction in vehicles on the road is combined with a multiplier, which is a weighted average of fatal, injury, and property damage only (PDO) accidents. This calculation provides an estimate of the accident reduction benefits associated with the Main Wharf rehabilitation.

Environmental Protection – Emissions Reduction:

Using the MOVES model for emissions in the northeast and assuming an average speed of 45 miles per hour, emissions rates for VOC(HC), NOX, SO2, PM2.5, CO, and CO2 were measured. These rates were then converted from grams per mile to calculate the reduction in tonnage of emissions due to the diversion from trucks and rail to marine transportation. Each pollutant was then converted to metric tons. The USDOT does not currently have recommended unit values for carbon, therefore carbon estimates were not included in this analysis.

7.2 Assumptions

The assumptions used in the estimation of economic benefits for the Market Street Marine Wharf Rehabilitation project are summarized in the table below.

Table 3: Assumptions Used in the Estimation of Economic Benefits

Variable Name	Detail	Unit	Value	Source
Trucking Costs	Truck	$ per mile	$3.20	Modal Experts
Tonnage Per Vehicle	Truck	Tons	25	Average based on truck movements at Port
Distance to Other Ports	New Haven	Miles	188	Google Maps
	Portland	Miles	50	Google Maps
	Boston	Miles	64	Google Maps
	Providence	Miles	109	Google Maps
	Searsport	Miles	160	Google Maps
	New York	Miles	281	Google Maps
	Baltimore	Miles	401	Google Maps
	Montreal	Miles	300	Google Maps
Local Miles Transportation Factor	Truck	Miles	10	HDR Assumption
Local Miles for Container Shipments	Truck	Miles	45	HDR Assumption
Sand and Gravel Cargo Diversion	New York	Percent	50%	HDR Assumption based on information from Port Director.
	Diverted to other ports as indicated in next Variable Detail	Percent	20%	HDR Assumption based on information from Port Director.
	Share handled by other terminals in local area	Percent	30%	HDR Assumption based on information from Port Director.
Share of Diversion by Port for other bulk and project cargoes	New Haven	Percent	28%	HDR Assumptions based on Port Size and Army Corps of Engineers information regarding port freight
	Portland	Percent	5%	HDR Assumptions based on Port Size and Army Corps of Engineers information regarding port freight. This excludes scrap metal.
	Boston	Percent	10%	HDR Assumptions based on Port Size and Army Corps of Engineers information regarding port freight
	Providence	Percent	28%	HDR Assumptions based on Port Size and Army Corps of Engineers information regarding port freight
	Searsport	Percent	28%	HDR Assumptions based on Port Size and Army Corps of Engineers information regarding port freight
Share of Diversion by Port for Container Service	New York	Percent	40%	HDR Assumptions based on Port Size and Army Corps of Engineers information regarding port freight
	Baltimore	Percent	40%	HDR Assumptions based on Port Size and Army Corps of Engineers information regarding port freight
	Montreal	Percent	20%	HDR Assumptions based on Port Size and Army Corps of Engineers information regarding port freight
Variable Name		**Unit**	**Value**	**Source**
Pavement Maintenance		Per Vehicle Mile	$0.10	Weighted average based on USDOT BCA Guidance, 2018
Capital Costs with longer useful life		$	$8.3 million	Based on components of construction cost estimate that have a useful life longer than 30 years
Useful Life		Years	50	Industry knowledge of construction components
Variable Name		**Unit**	**Value**	**Source**
Fatal Accidents		Per 100 million VMT	1.185	BTS Table 2-17: Motor Vehicle Safety Data (updated Feb 2017); Rates are for 10 year average from 2006-2015
Injury Accidents		Per 100 million VMT	78.511	

Property Damage Only Accidents		Per 100 million VMT	192.510	
Cost of Fatality		$	$9,600,000	US DOT BCA Guidance 2018
Cost of Injury		$	$174,030	US DOT BCA Guidance 2018
Property Damage Costs		$	$4,198	US DOT BCA Guidance 2018
Mode	**Variable Name**	**Unit**	**Value**	**Source**
Truck	NOX	Grams Per Mile	4.14	MOVES, Long Haul Combination Truck 45 miles per hour, 2020*
	CO	Grams Per Mile	0.99	MOVES, Long Haul Combination Truck 45 miles per hour, 2020*
	PM	Grams Per Mile	0.12	MOVES, Long Haul Combination Truck 45 miles per hour, 2020*
	VOC	Grams Per Mile	0.15	MOVES, Long Haul Combination Truck 45 miles per hour, 2020*
	CO2	Grams Per Mile	1998.83	MOVES, Long Haul Combination Truck 45 miles per hour, 2020*
	SO2	Grams Per Mile	0.01	MOVES, Long Haul Combination Truck 45 miles per hour, 2020*
Valuation	NOX	$ Per Metric Ton	$8,276	Final Regulatory Impact Analysis Corporate average Fuel Economy for MY 2017-MY2025 Passenger Cars and Light Trucks; USDOT BCA Guidance 2018.
	CO	$ Per Metric Ton	-	Victoria Transport Policy Institute, Air Pollution Costs Spreadsheet
	PM	$ Per Metric Ton	$378,580	Final Regulatory Impact Analysis Corporate average Fuel Economy for MY 2017-MY2025 Passenger Cars and Light Trucks; USDOT BCA Guidance 2018.
	VOC	$ Per Metric Ton	$2,100	Final Regulatory Impact Analysis Corporate average Fuel Economy for MY 2017-MY2025 Passenger Cars and Light Trucks; USDOT BCA Guidance 2018.
	CO2	$ Per Metric Ton	-	USDOT does not have a recommended value for the damage costs of CO2 emissions at this time.
	SO2	$ Per Metric Ton	$48,913	Final Regulatory Impact Analysis Corporate average Fuel Economy for MY 2017-MY2025 Passenger Cars and Light Trucks; USDOT BCA Guidance 2018.

*A time series of assumptions is included in the benefit-cost analysis model that accompanies this application and technical appendix.

8. Summary of Findings and BCA Outcomes

With the Main Wharf rehabilitation, non-discounted shipper cost savings would total $207.97 million. This represents 88 percent of total benefits, and the largest portion of the estimated benefits for the project. Because of this, a sensitivity analysis is conducted that reduces these total benefits. Accident reduction benefits associated with the reduction in truck diversion due to the rehabilitation of the Wharf make up approximately 7 percent of the aggregate benefits generated. Emissions reduction, pavement maintenance savings, and residual value are also important benefits, but they comprise a smaller portion of the overall estimated benefits.

Table 4: Estimates of Economic Benefits, Millions of 2017 Dollars

Primary Selection Criteria	Benefit Categories	Undiscounted Benefits	7% Discount Rate	3% Discount Rate
Safety	Accidents Benefits (2017$)	$ 16.81	$ 6.91	$ 11.19
State of Good Repair	Residual Benefits (2017$)	$ 5.00	$ 0.98	$ 2.46
	Pavement Maintenance Benefits (2017$)	$ 6.21	$ 2.55	$ 4.13
Economic Competitiveness	Shipper Cost Savings Benefits (2017$)	$ 207.97	$ 85.46	$138.44
Environmental Protection	Emissions Reduction Benefits (2017$)	$ 1.64	$ 0.82	$ 1.19
Quality of Life	Qualitative only	n/a	n/a	n/a
Total Benefit Estimates		$ 237.64	$ 96.72	$157.42

This benefit cost analysis compares the monetized benefits listed above to the overall project cost. Total discounted costs are estimated to be $20.85, and $96.72 million is estimated for total benefit (discounted at 7%). Annual costs and benefits are computed over the lifecycle of the project (20 years). The project is estimated to yield a Benefit/Cost ratio of approximately 7.41. Considering all monetized benefits and costs, the estimated internal rate of return of the project is 44.03 percent.

Table 5: Estimates of Economic Benefits, Millions of 2017 Dollars

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	$96.72	$157.42
Total Discounted Costs	$20.85	$27.66
Net Present Value	$75.87	$129.76
Benefit / Cost Ratio	7.41	10.95
Internal Rate of Return (%)	44.03%	
Payback Period (years)	7	

As discussed previously, if the Port is repaired, there has been extensive interest from a container shipper to move a portion of his operations to the Market Street Marine Terminal. This movement is expected to bring an additional 12,000 containers by 2024 and up to 15,000 containers by 2028. Of these containers, approximately half would be diverted from other Ports, and 20 percent of these (approximately 1,200 in 2025) would come from Montreal. The other half of the containers would be new business that would result from the level of service provided by the Port and the ability of the shipper to expand his business due to increased efficiencies.

Following the same methodology as the base analysis, when these new containers are accounted for, the Net Present Value of the project at a 7 percent discount rate increases to $105.62 million, resulting in a BCR of 9.91 and an internal rate of return of approximately 48.56 percent.

9. BCA Sensitivity Analysis

The BCA outcomes presented in the previous sections rely on a large number of assumptions and long-term projections, both of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the BCA outcomes: the “critical variables.”

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the final results would vary with reasonable departures from the “preferred” or most likely value for the variable; and
- Assess the robustness of the BCA and evaluate, in particular, whether the conclusions reached under the “preferred” set of input values are significantly altered by reasonable departures from those values.

The outcomes of the quantitative analysis for the Market Street Marine Terminal Rehabilitation, using a 7 percent discount rate are summarized in the table below. The table provides the percentage changes in project NPV associated with variations in variables or parameters (listed in row), as indicated in the column headers.

For example, a 25 percent increase in capital cost estimate represents a -0.25 percent change in NPV and a BCR of 7.44. The following table presents the results of the sensitivity analyses that were conducted for this benefit-cost analysis. The benefit-cost model that is included along with this technical appendix and application narrative can also be modified to test additional sensitivities in assumptions.

Table 6: Quantitative Assessment of Sensitivity, Summary (Millions of 2017$)

Parameters	Change in Parameter Value	New NPV	Change in NPV	% Change in NPV	New B/C Ratio
Change in Terminal Demand	Assume anticipated Sand and Gravel (bulk cargo) demand is reduced by 50%	$28.45	$47.42	166.7%	3.44
Shipper Cost Savings	Shipper cost per mile for trucking assumed $1/mile as opposed to $3.20/mile	$17.12	$58.75	343.2%	2.49
Capital Cost Estimate	25% Increase	$76.12	-$0.25	-0.3%	7.44